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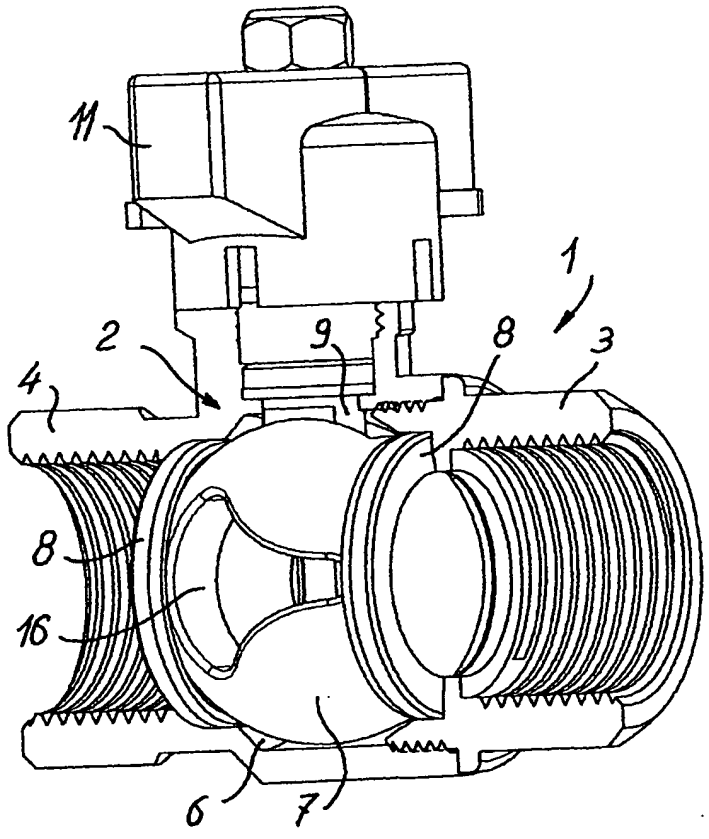

(57) Abstract: Ball valve (1) comprising a ball shutter (7) rotatably and tightly housed in a valve body (2) in which in a component of the ball valve formed by the shutter (7) or the body (2) of the valve (1) a contoured opening (16) is provided which may have different contours. With a lobed contour the valve is adapted to be used as a temperature adjusting valve whereas with a "saddle"-shaped contour the valve may be used both as a temperature adjusting valve and as a balancing valve in heating plants.

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IMPROVED BALL VALVE

Background of the invention

The present invention relates to an improved ball valve according to the preamble of claim 1.

Several embodiments of ball valves conventionally comprising a shutter element of ball form, which can be either hollow or solid and provided with a diametrical throughgoing hole having circular inlet and outlet ports are already known. The ball shutter is so supported as to be able of turning through 90° between two supporting and sealing gaskets, made of a synthetic material and housed in corresponding seats of the valve body. The reciprocating 90° rotary movement allows to pass from the closure or on position to the maximum opening or off position and vice-versa.

In the above mentioned construction, the flow variation occurring in switching from the opening position to the closing position, and vice-versa, is not proportional, in percentage, to the rotary movement of the stem or handwheel rotatively driving the ball shutter element. Accordingly, prior ball valves are used as opening/closing or on/off valves, since their construction prevents them from being used as adjusting valves.

In order to use ball valves as adjusting valves for thermic adjustment in heating plants, a first prior solution, adopted by the Swiss Company Belimo Automation AG of Wetzikon, provides to arrange, upstream of the ball, in the flow direction, and in front of the ball supporting and sealing gasket, an adjusting diaphragm or

disc having a contoured opening laterally defined by two lobes and having a substantially triangular shape or V-shape, said diaphragm being supported by a resilient ring element, and being made of a synthetic material.

The diaphragm inner surface contacting the ball shutter is also spherical and both diaphragm lobes forming the V-shaped opening are rather thin. As per se known, said V-shape is a consequence of the known relationship of the small-step rotation of the ball shutter, obtained by known electric actuators or motors, and the corresponding throughgoing apertures of the shutter.

Even if the above construction is adapted to provide a percentage or equipercentage adjustment characteristic curve and, accordingly, is suitable for use in heating systems, with a resulting heat power characteristic following a 45° slanted straight line (in a diagram providing the flow-rate on the Y-axis and the opening or rotary degree on the X-axis of the ball), it has been practically found that this approach is affected by several drawbacks and disadvantages.

At first, the contoured seat diaphragm and its locating resilient ring represent additional components of the valve.

These two components require, construction-wise, additional machining operations on the valve body and, moreover, additional assembling steps for assembling them. This, jointly with the used materials, causes an increase of the making cost.

The lobes of said contoured diaphragm are operatively subjected to a unidirectional pressure stress toward the ball, due to the inlet fluid flow pressure. Moreover, as said diaphragm is used in a heating system, it would be also subjected to the thermal stress due to the hot water, for example at a temperature of 70-80°C, thereby the cumulative effect of the mentioned pressure and thermal stresses on said contoured diaphragm could push said diaphragm, either toward the ball or the inside of the ball shutter throughgoing hole,

which could make the rotary movement of the ball shutter "harder", or hinder or completely prevent said movement and lock the shutter.

A further prior solution provides to form the ball shutter supporting and sealing gasket on the outlet side, with a contoured port or opening and to make it of a synthetic material, a glass fiber reinforced synthetic material, or a metal material. By this approach, the contoured-port gasket or supporting seat would not have the drawbacks of the Belimo's valve, but would requires, from one side, to use more expensive gaskets or seats (for example glass fiber reinforced synthetic material seats, or sinterized and graphite impregnated steel seats) and, on the other side, a ball coated by Polyond TM, the ball surface, to provide a "super-spherical" shutter, being moreover coated by polyethylene terephtalate (PTFE) and nickel solutions, which would require additional machining steps susceptible to increase the valve cost.

Moreover, it should be apparent that by using discs or gaskets provided with a V-shaped opening or port, a good thermal adjustment can be obtained; however, it would not be possible to provide a balancing adjustment in heating plants or systems which operate, as is well known, to gradually adjust the flow-rate by constant opening increments of the shutter. This balancing function is provided, at present, by specifically designed balancing valves provided with an axially movable shutter. However, said prior art balancing valves are affected by flow-rate variations due to an imputity particle accumulation depositing on the throughgoing port, which is a circular crown arranged around the shutter and, moreover, they have a comparatively high length.

Summary of the invention

Accordingly, the object of the present invention is to provide an improved ball valve suitable for adjusting applications in general, and particularly for the thermal adjustment in heating plants, which

ball valve is free of the mentioned drawbacks and disadvantages of the prior art valves, and which does not require additional components or special materials or gaskets.

Within the scope of the above mentioned object, a further aspect is that to provide a ball shutter profiled or contoured bifunctional opening, i.e. suitable to allow the valves according to the invention to be used both as thermal adjusting valves and as balancing valves. This would also involve a simplification of the storing requirements.

The above mentioned objects are achieved by a ball valve having the features of claim 1.

Further advantageous embodiments are inferable from the dependent claims.

As taught in Claim 2, a percentage adjustable flow rate pattern is obtained, thereby obviating possible turbulences in the liquid passing through the throughgoing hole of the ball.

As taught in claim 3, the ball shutter does not require additional components and can be made as a single-piece.

As taught in claim 4 the improved ball valve is adapted to provide a percentage adjustment characteristic curve and is suitable to be used as a thermal adjusting valve in heating plants.

As taught in claim 5 the improved ball valve having a "saddle"-shaped opening is suitable to be used both as a thermal adjusting valve and as a balancing valve in heating plants.

As taught in claim 6, said ball shutter can be made by conventional making methods and machining operations, or machine tools.

As taught in claim 7, an advantageous and efficient arrangement of the contoured ports through the valve body is provided.

Claim 8 teaches how to obtain the desired contoured opening.

As taught in claim 9, the contoured ports or openings are provided as plug inserts which can be respectively engaged in the ball shutter throughgoing hole or in the valve body adjoining a housing seat or recess for an annular gasket. This approach will allow to transform prior conventional ball valve for an on/off operation into ball valves the flow rate of which can be adjusted in percentage.

As taught in claim 10, the inventive valve is coupled to a known rotatively driving device, which is suitable either for a manual and/or for an automatic drive.

Claim 11 relates to a specifically designed ball shutter suitable to transform a ball valve from an on/off valve into an adjusting valve, by simply replacing the ball shutter of the valve.

Claim 12 discloses a solution making the inventive valve suitable for use in condominial heating systems.

Thus, the ball valve and ball shutter according to the invention provide several and important advantages.

At first, it is not necessary to use, for forming the ball shutter and valve, additional components like contoured diaphragms or discs or other valve components made of materials different from conventional materials, such as brass, bronze, or steel.

Depending on the used shutter, the ball valves can be either used exclusively as thermal adjusting valves, by providing a V-shaped opening, or as valves suitable to be used, at will, as thermal adjusting valves or balancing valves, with a "saddle"-shaped opening, in both cases with a good yield. With respect to prior art balancing valves, the flow-rate variation trend due to the particles depositing in the throughgoing opening is substantially reduced. Moreover, the shutter diameter being the same, the ball shutter provides a port larger than of prior art axial shutter, the length of the ball valves is much smaller, which, together with the greater

constructional simplicity of the ball valves, would involve reduced manufacturing costs.

The modification of the ball shutter, or of the valve body, according to the invention, with respect to conventional ball shutters or valve bodies, can be practically made at a very low cost, since the proposed improvement can be mainly performed in the same making step of prior ball shutters or valve bodies, for example by using a molding punch having for example an operating contoured or shaped end portion, and by known chip removal machining operations, which can be carried out on conventional machine tools, or with a laser working. Accordingly, the general making time and cost remain substantially unchanged. Moreover, the ball shutter according to the invention does not require specifically designed finishing operations and, for supporting it, conventional gaskets can be used, the valve body remaining unchanged. This allows to simply transform a ball valve from an on/off valve to an adjusting valve and vice-versa, by merely changing the ball shutter. In addition, by integrating the adjusting valve in the valve body, said valve can be indifferently used as an on/off drive valve or as an adjusting valve, and more particularly as a thermal adjusting valve or as a balancing valve. With the valve according to the invention it is moreover possible to associate, at will, known rotary driving devices, either of a manual or of an automatic type, for example gear transmission handwheels, or driving assemblies or units including either electric or pneumatic motors or actuators and the related control electronics, to be optionally coupled to a control computer.

The GB Patent No. 1 550 119 discloses an improved plug valve with a parallel and taper plug or a spherical plug which has a non-circular throughgoing hole extending through the whole thickness of the shutter, and more specifically, symmetrically with respect to a middle vertical plane, that is the rotary axis of the shutter. This would involve, on the one hand, a rather complex

machining and, on the other hand, contoured gaskets. Similar valves can not be used as thermal adjusting valves or as balancing valves in heating plants.

The document EP 0 503 195 B1 discloses a ball valve having improved adjusting characteristics provided by a gasket provided with different contoured openings, for example in the form of a circle sector, a slot or with a plurality of small holes. With the shown contoured openings is not possible to employ the suggested valves as thermal adjusting valves or balancing valves. Thus, in this prior valve, a special gasket instead of a standard one would be necessary.

The document EP-A-0 085 565 discloses plug valves including a gasket having a troughgoing opening in the form of a circular sector having an horizontal axis. Accordingly, also this valve would require a specifically designed gasket which, in turn, requires a special locking thereof and, indirectly, a special design of the whole valve.

Brief description of the drawings

Further characteristics, advantages and details of the improved ball valve and improved shutter according to the invention will become more apparent hereinafter from the following disclosure of four embodiments thereof, with reference to the accompanying drawings, where:

Figures 1 to 4 show a first embodiment of an improved ball valve according to the invention, partially in view and partially cross-sectioned, the supporting gaskets and ball shutter being shown in perspective, said shutter being respectively shown in its closure or on position in figure 1, in its 30% opened position in figure 2, in its 70% opened position in figure 3 and in its 100% opened or off position in figure 4;

Figures 5 to 8 show a second embodiment of the improved ball valve according to the invention, partially in view and partially

cross-sectioned, the gaskets and ball shutter being shown in perspective, said shutter being respectively shown in its closure or on position in figure 5, in its 30% opening position in figures 6, in its 70% opening position in figure 7, and in its 100% opening or off position in figure 8, likewise to the corresponding figures 1 to 4 of the first embodiment;

Figures 9 to 12 show a third embodiment of an improved ball shutter of a ball valve according to the present invention, said shutter being respectively shown in a front view in figure 9, in a frontal perspective view in figure 10, in a perspective back view in figure 11, and in a vertical sectional view taken according the sectional plane XII-XII of figure 9 in figure 12; and

Figures 13 to 15 show a fourth embodiment of an improved ball shutter of a ball valve according to the present invention, said shutter being respectively shown in a front view in figure 13, in a perspective back view in figure 14, and in a vertical sectional view taken according to the sectional plane XV-XV of figure 13 in figure 15.

Description of the preferred embodiments

In above mentioned figures like elements are indicated by the same reference numbers. In the drawings the reference number 1 generally indicates a ball valve. Said ball valve comprises, in a per se known manner, a valve body 2, provided with an inlet fitting 3 and outlet fitting 4, therebetween an housing chamber 6 for housing a conventional ball shutter 7 is provided, that is formed by a ball having a cylindrical throughgoing hole 12, as shown and indicated in figures 5 to 8. The shutter 7 is supported by two sealing opposite gaskets 8 made of a synthetic material. The reference number 9 indicates a stem which is rotatably and sealingly supported in the valve body 2 and is engaged, on a side, in the ball shutter and, on the other side, in a rotary control element 11. The latter can comprise, at will, a handwheel, knob, lever or the like (for a manually operated

rotary drive), or a control or drive unit including an electric motor or, depending on the application, a pneumatic motor, or actuator provided with a suitable control portion (for an automatic rotary drive or control).

As shown, the known ball shutter is provided with a diametrically throughgoing hole 12, the inlet port 13 and outlet port 14 of which have a circular shape and a uniform throughgoing diameter, as shown in figure 5.

As above disclosed, a prior exemplary ball valve allows, by a 90° rotation of the ball shutter 7, a perfect opening/closing drive, however with flow-rates which are not proportional, in percentage, to the rotary angles of the driving or control element 11, as required, on the contrary, for example in adjusting valves for the adjusting of the temperature in a heating plant branched on several floors of a building multi-floor heating plant..

It is here that the invention intervenes, according to which one of the ports 13, 14 of the throughgoing hole 12 of the improved shutter 7 departs from the circular configuration and is provided with a throughgoing hole 12 having an end wall 7B in which is provided a contoured port or opening 16 which for a temperature adjusting valve will present a shape similar to the known V-shape or lobed shape, as shown in figures 9 to 12 having the lobes 7A, that is suitable to allow an adjustment, in percentage, of the flow-rate, proportionately to the rotary angle of the stem 9, or of the control or drive element 11 thereof.

The contoured pattern or opening 16 formed in the thin end wall 7B of the ball shutter 7 may have the known lobed shape as shown in figures 9 to 12 (for achieving a percentage characteristic curve, that is for a thermal adjustment in heating plants) or, according to a further embodiment of the present invention, a different form, for example a substantially triangular shape with rounded sides (fig. 1 to 8) or as illustrated in figures 13 to 15 which

show an important embodiment having a "bicycle saddle" shape. Said "saddle" shape is very important because with such a contoured opening it is possible to achieve good results both in the use of the improved ball valve as a temperature adjusting valve as well as in the use as a balancing valve for heating plants. Since according to the present invention the contoured opening 16 is directly formed through an end wall 7B of the shutter 7, i.e. by using the material of said shutter itself, and no deformable part or component is provided, the contoured opening 16 could be indifferently provided at the inlet port 13 or at the outlet port 14 of the shutter 7. The provision of the contoured pattern at the inlet port, i.e. at the inlet fitting 3 of the valve 1, would advantageously allow to safely prevent any turbulences from forming in the flow inside the valve.

In actual practice, the contoured pattern 16 is advantageously formed during the conventional making of the ball shutter 7, for example by molding, in particular hot molding for a brass shutter, in which operation the front end portion of the throughgoing hole forming punch could be shaped correspondingly to the desired contoured throughgoing port 16, thereby making, at the end portion of the operating stroke thereof, said contoured opening or port 16 through the ball or the end wall 7B. The following chip machining finishing operation will be likewise carried out, and by conventional automatic tool machines. The ball shutter 7 according to the invention can be also made by casting. The contoured opening 16 in the shutter end wall 7B could also be obtained by laser working whereas the cylindrical hole 12 may be obtained in any known manner.

In operation of the valve according to the invention, the rotary movement of the shutter 7 from the closing position (figure 1) to the maximum opening position (figure 4) and vice-versa, will provide -- with a triangular or lobed opening 16, figures 1 to 12 -- a variable

flow-rate proportional, in percentage, to the rotary movement of the control or drive element 11, or of the stem 9 whereas with a "saddle"-shaped opening 16, figures 13 to 15 the valve will provide a variable flow-rate which represents a good compromise for the use both as a thermal adjusting valve and a balancing valve. This "saddle"-shaped opening 16 will, therefore, allow a great broadening of the ball valve application fields, such as in heating, ventilating and air conditioning system applications. For example, in a condominial multi-floor heating system, it would be necessary to preset the flow-rate or calibration of the valves to set the desired flow rate, which could be performed, by a manual adjustment, by associated known (and not shown), locking means for locking the rotary drive or control element or, in motor driven valves, by affecting the power supply or motor control program. Similarly, the known balancing valves can be substituted in general with an adjusting valve with a shutter having a "saddle"-shaped opening 16, the contour of which has been determined according to the present invention for the above illustrated double use.

Furthermore, if a coarser flow-rate percentage adjustment would be sufficient, then the embodiment of the invention shown in figures 5 to 8 can also be used.

In the embodiment shown in figures 5 to 8, the seat 16 is formed in the ball valve body 2 at the inlet or outlet fitting 3, respectively 4, and, more specifically on a front inner partition wall 18, on the ball shutter 7 side. As shown in the drawings, the contoured seat 16 has the longitudinal axis 16a thereof arranged on a middle horizontal plane of the ball valve 1, or of the ball shutter 7, in the assembled position thereof. From figures 5 to 8 it is moreover possible to see that the opening 16 increases in the turning direction of the ball shutter 7 from its closing position to its opening position.

In this case too, the contoured seat 16 is formed during the conventional machining steps, i.e., at first by using the same molding

punch and then by performing the following chip removal machining operations, or by a laser working. The spacing, even if very short, between the ball shutter 7 and the contoured opening 16 in the wall 18 of the valve body 2, could cause, in some operating conditions, a small turbulence effect which, however, would affect only in a limited degree the adjustment evenness, which would be held substantially even along the major part of the 90° turning displacement of the ball shutter 7, with a slight variation at the end portions of this stroke. The shutter 7 of this second embodiment is shown as having a traditional throughgoing hole 12 of constant diameter. As in the first embodiment, the adjustment would be substantially the same, even if a known hollow-ball shutter would be used.

From figures 5 to 8 of the drawings, it should be easily apparent that the shutter is shown in those same positions shown in figures 1 and 2 to 4 of the first embodiment.

From the constructional and operational disclosure of the ball valves according to the invention, it should be apparent that they efficiently solve the above mentioned object and achieve the mentioned advantages.

In particular, an actual lack of additional components, as well as of any special surface finishing machining operations both on the ball shutter and on the valve body, as well as the use of conventional sealing gaskets are to be pointed out. Furthermore, it would be possible to provide, within the scope of the invention, differently contoured ports or openings for achieving flow rates varying according to different curves, for specific use applications.

Moreover, it would also be possible, within the scope of the invention, to form the contoured ports 16 in metal plug elements, not specifically shown, as it would be immediately apparent to one skilled in the art, to be engaged in the ball shutter or in the valve body, to transform on/off ball valves into adjusting ball valves.

CLAIMS

1. An improved ball valve, comprising:
- a valve body having an inlet fitting, an outlet fitting and a middle chamber for housing a shutter therein,
- a ball shutter, rotatably and tightly supported in said valve body between two opposite annular gaskets,
- a stem or the like, coupled to rotary means for rotatively driving said ball shutter,
wherein a component of the ball valve, different from said ball shutter and valve body, is provided with a contoured opening affecting the flow-rate delivered by said valve, characterized in that said contoured opening (16) is directly formed through the ball shutter (7) or the valve body (2).

2. An improved ball valve according to Claim 1, characterized in that said contoured opening (16) is formed at an inlet port (13) or outlet port (14) of the throughgoing hole (12) of said ball shutter (7), preferably at said inlet port (13).

3. An improved ball valve according to Claims 1 and 2, characterized in that said ball shutter (7) is made as a single piece.

4. An improved ball valve according to one or more of the preceding Claims, characterized in that said contoured opening (16) has a V-shaped form or a lobed (7A) form (Figures 9 to 12).

5. An improved ball valve according to one or more of the preceding Claims, characterized in that said contoured opening (16) has a "saddle"-shaped form (Figures 1 to 8 and 13 to 15).

6. An improved ball valve according to one or more of the Claims 3 to 5, characterized in that said ball shutter (7) is made by a molding punch having an operating shaped end portion, or by casting, and being then machined by chip removal machining operations or by laser working.

7. An improved ball valve according to Claim 1, characterized in that said contoured opening (16) is formed through a cross partition wall (18) of said valve body (2) adjoining a known seat for supporting therein a sealing gasket (8) for said ball shutter (7), preferably by a laser working.

8. An improved ball valve according to one or more of the preceding Claims, characterized in that said contoured opening (16) is obtained by laser working in a end wall (7B) of said shutter throughgoing hole (12).

9. An improved ball valve according to Claim 7, characterized in that said contoured opening (16) is formed through an element which can be introduced, plug-wise, into the throughgoing hole (12) of the ball shutter (7), or into the valve body (2), at a position adjoining a supporting and sealing gasket (8).

10. An improved ball valve according to one or more of the preceding claims, characterized in that said ball shutter (7) is coupled to a manual drive control element, or an automatic drive control element, for example an electric or pneumatic motor or actuator.

11. A ball shutter for a ball valve, characterized in that said ball shutter is made according to one or more of Claims 2 to 6.

12. A ball valve according to one or more of the preceding claims, characterized in that said manual rotary control element (11) is coupled to a locking device for locking said control element (11) at a set rotary or calibrating position.

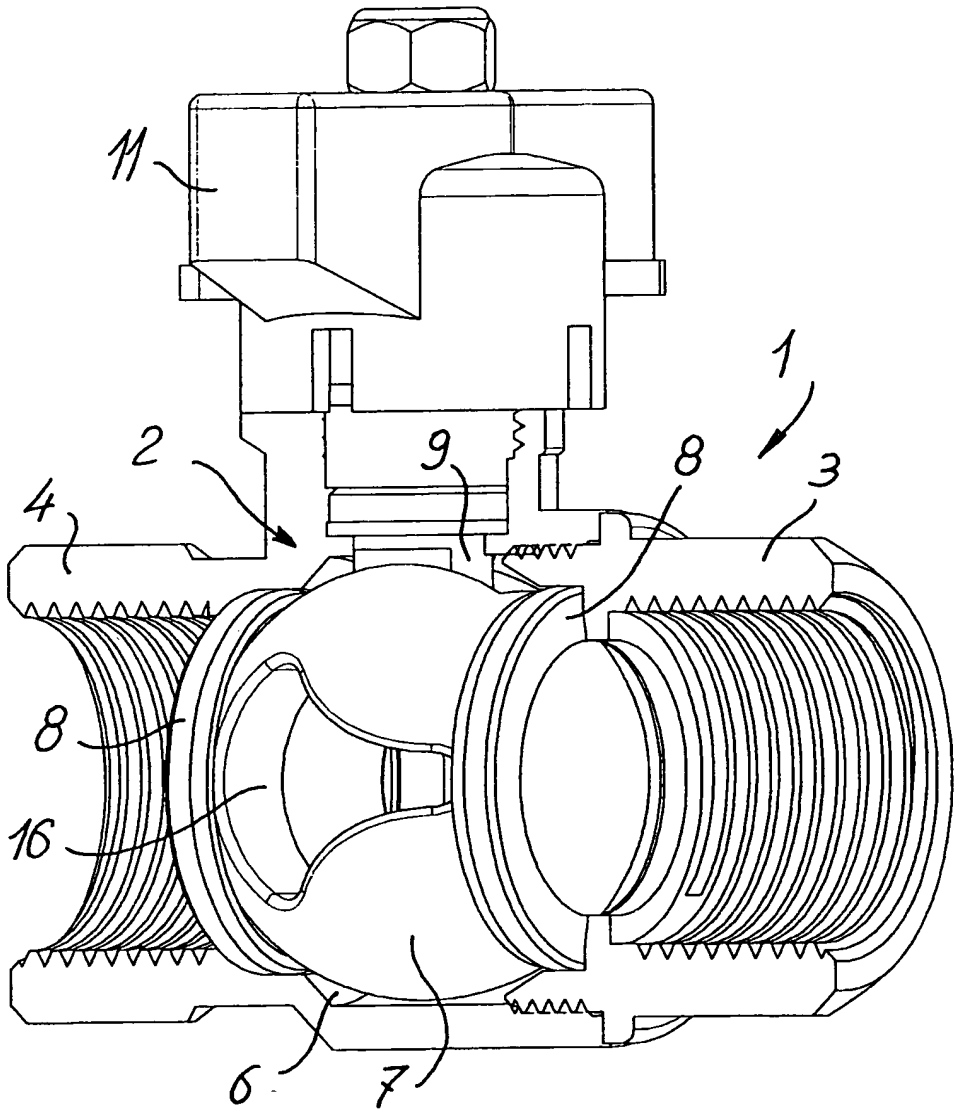

FIG. 1

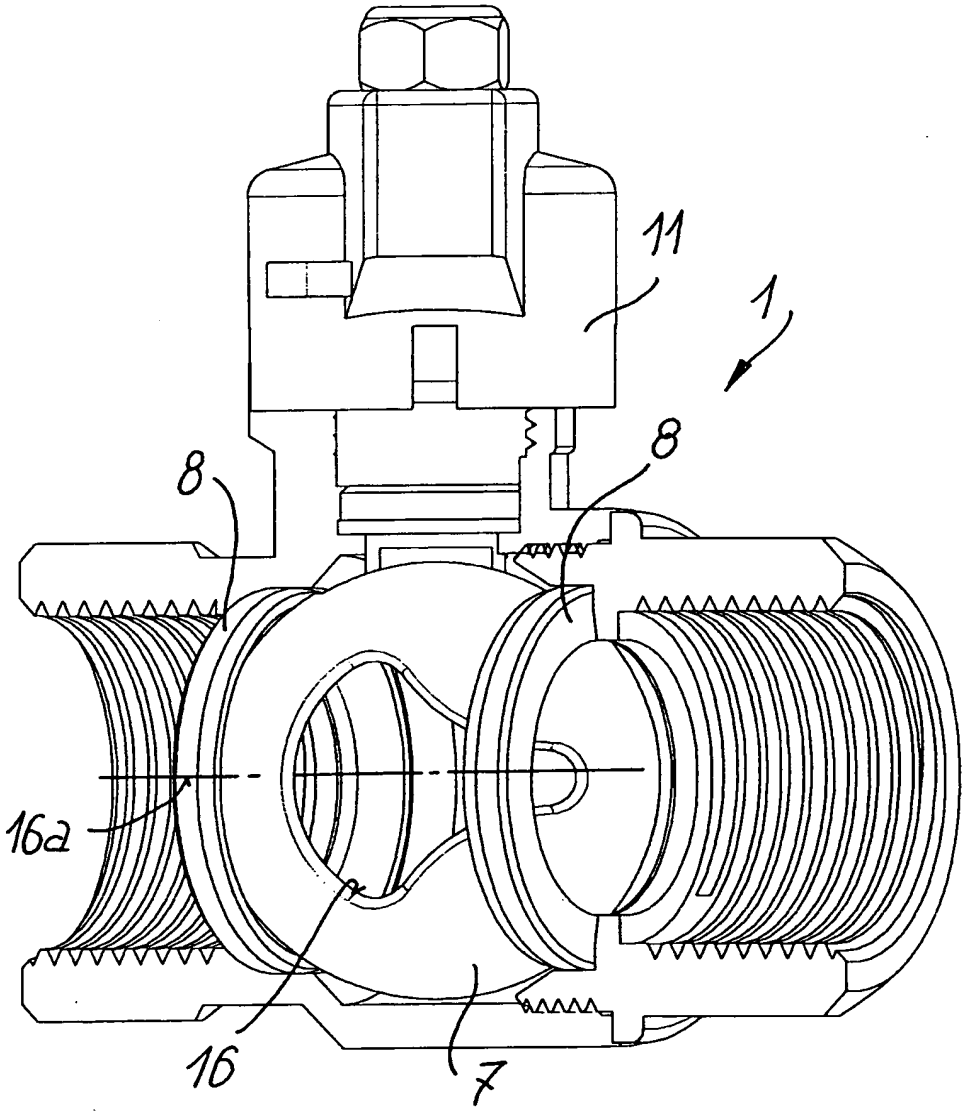

FIG. 2

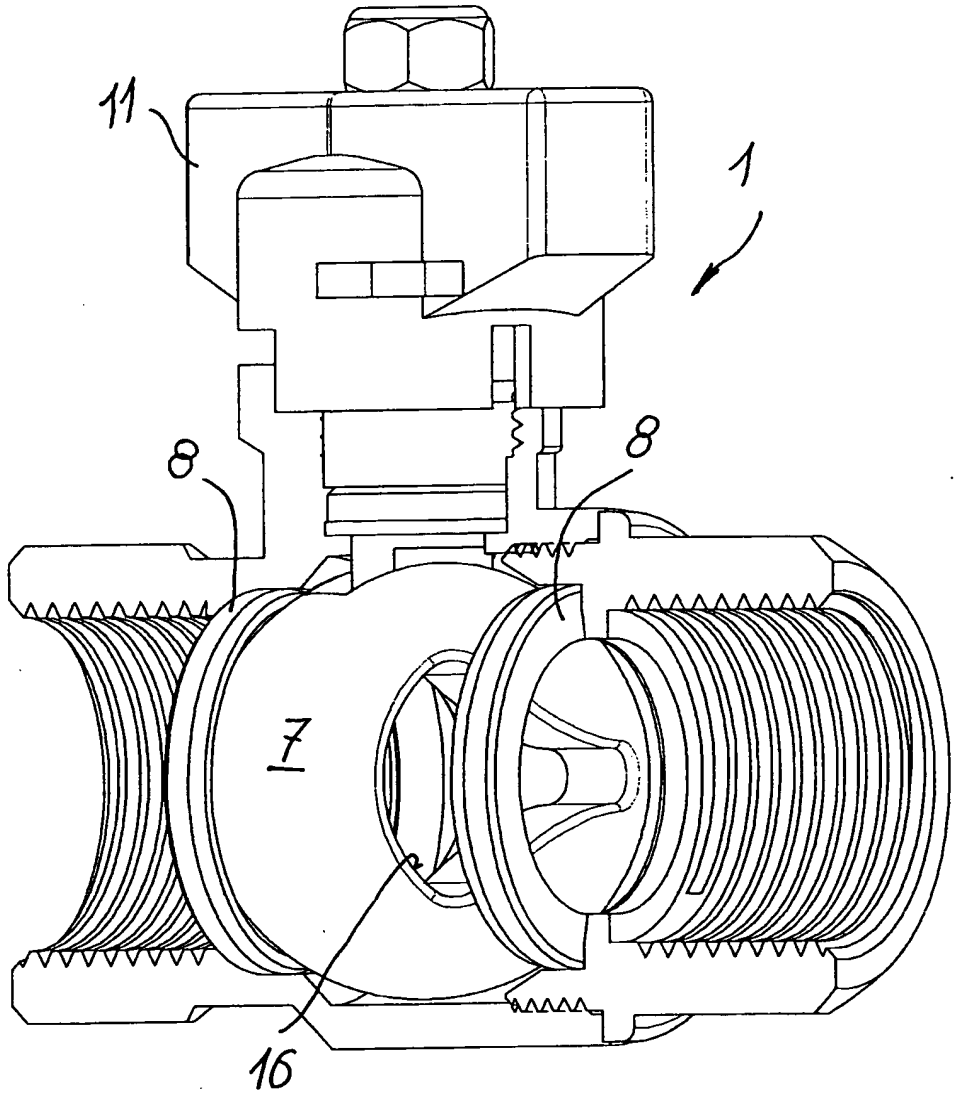

FIG. 3

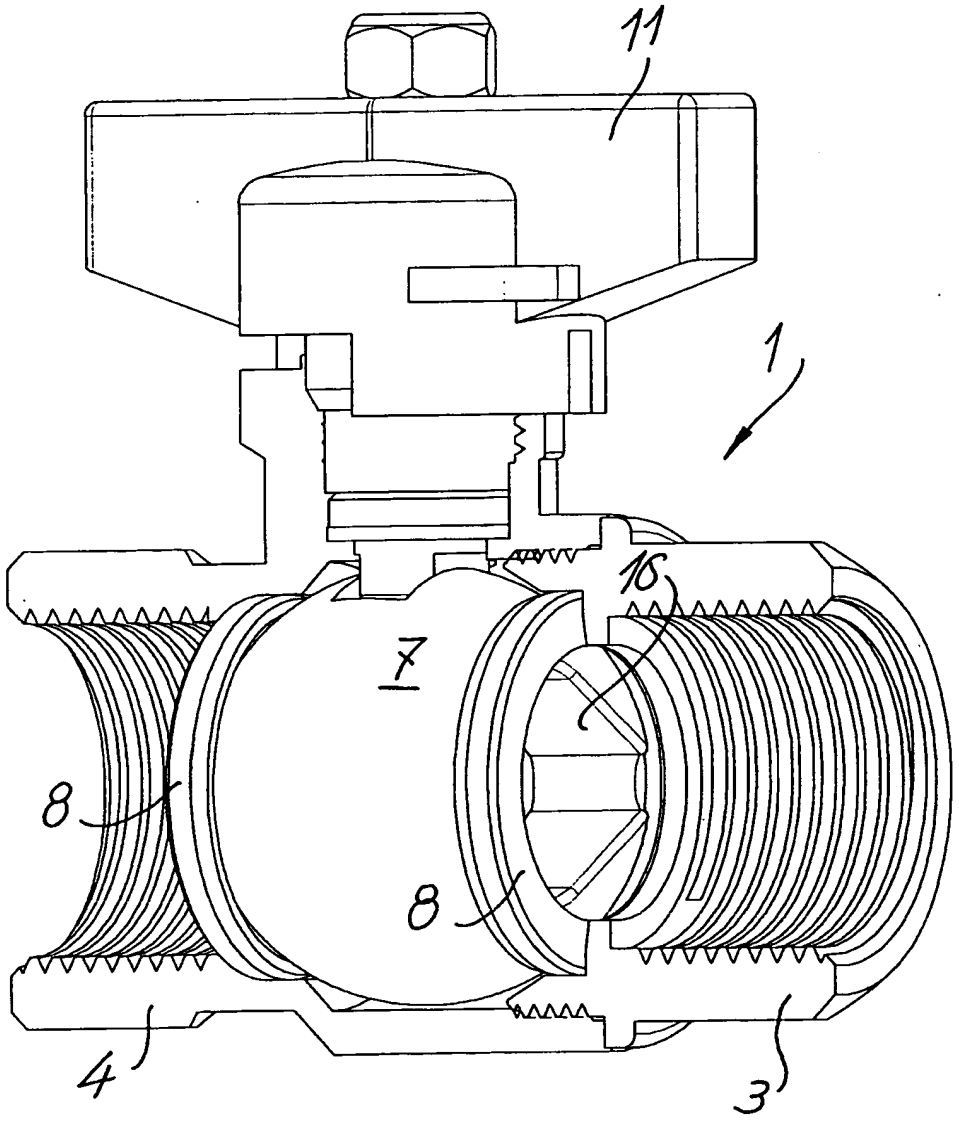

FIG. 4

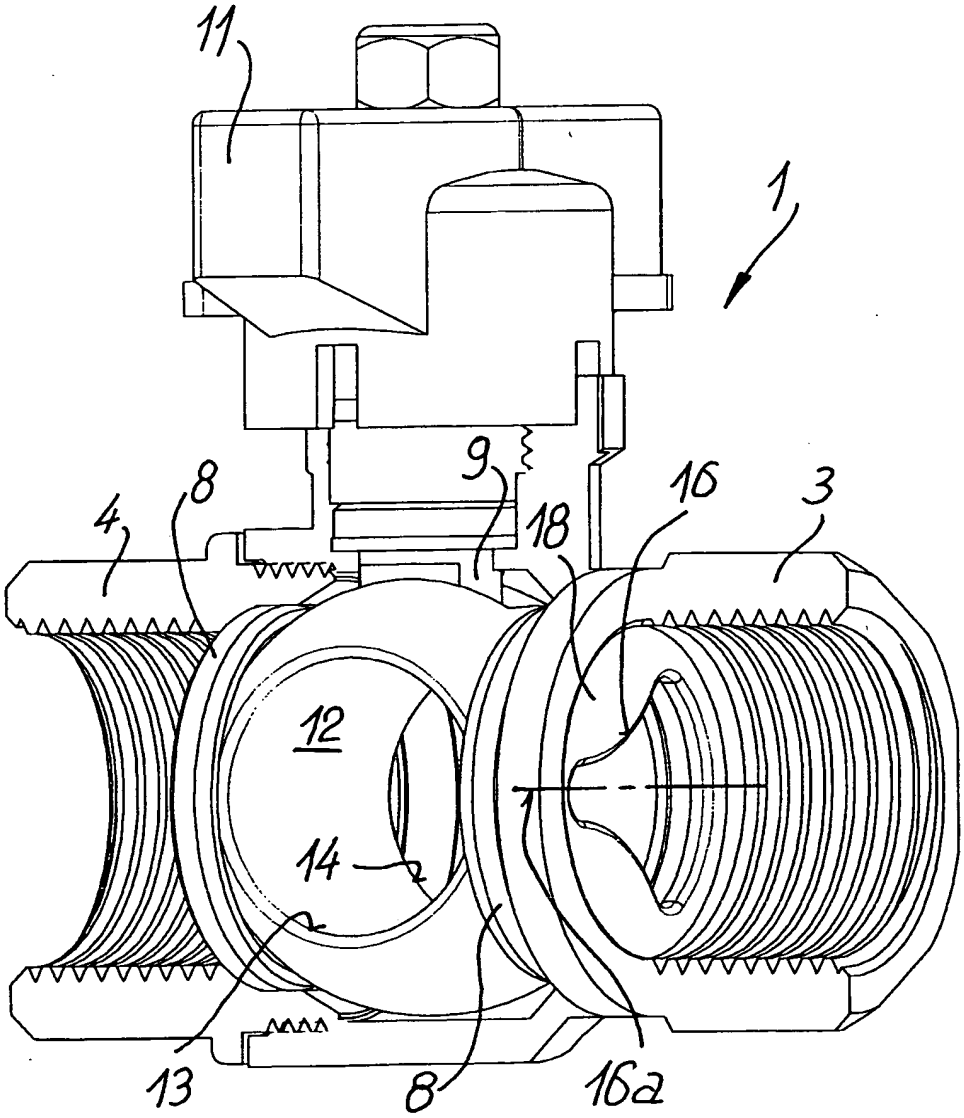

FIG. 5

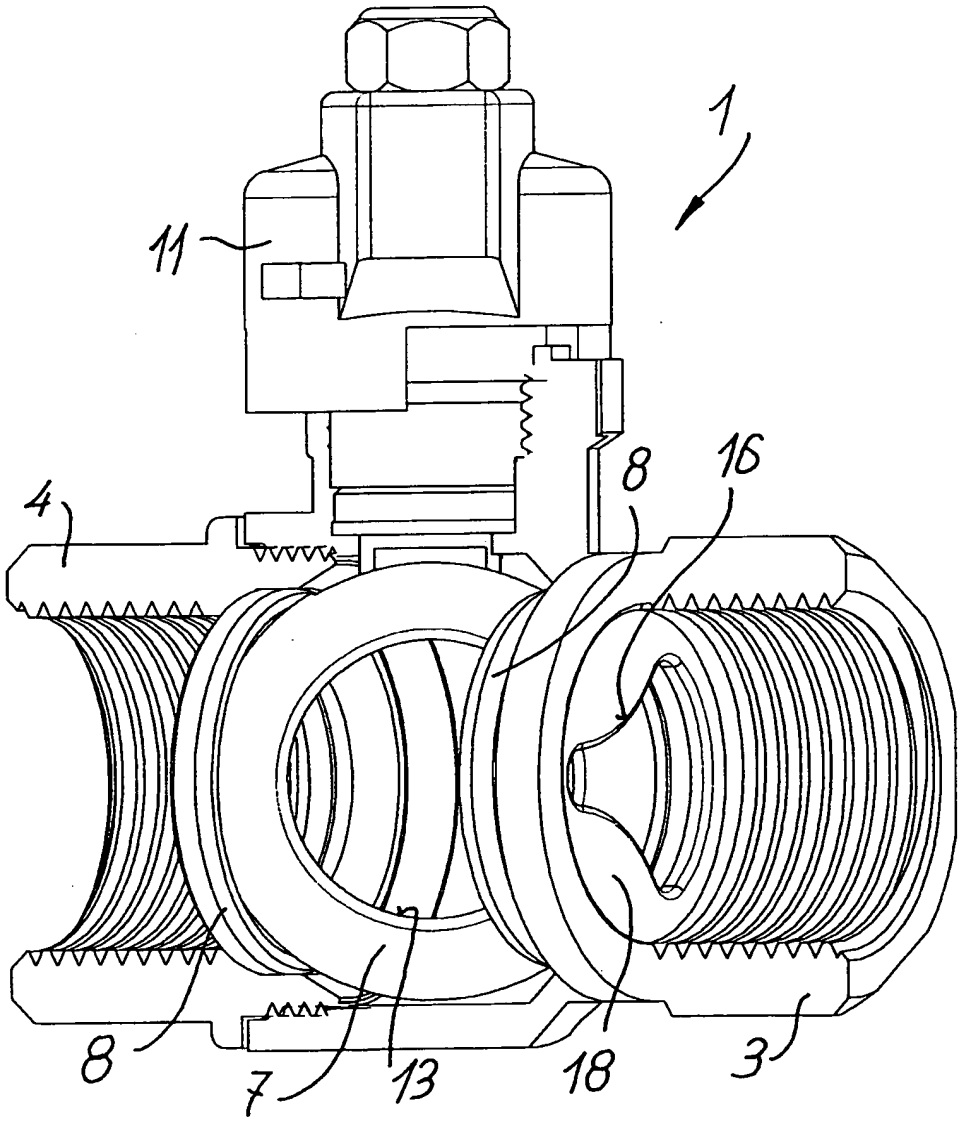

FIG. 6

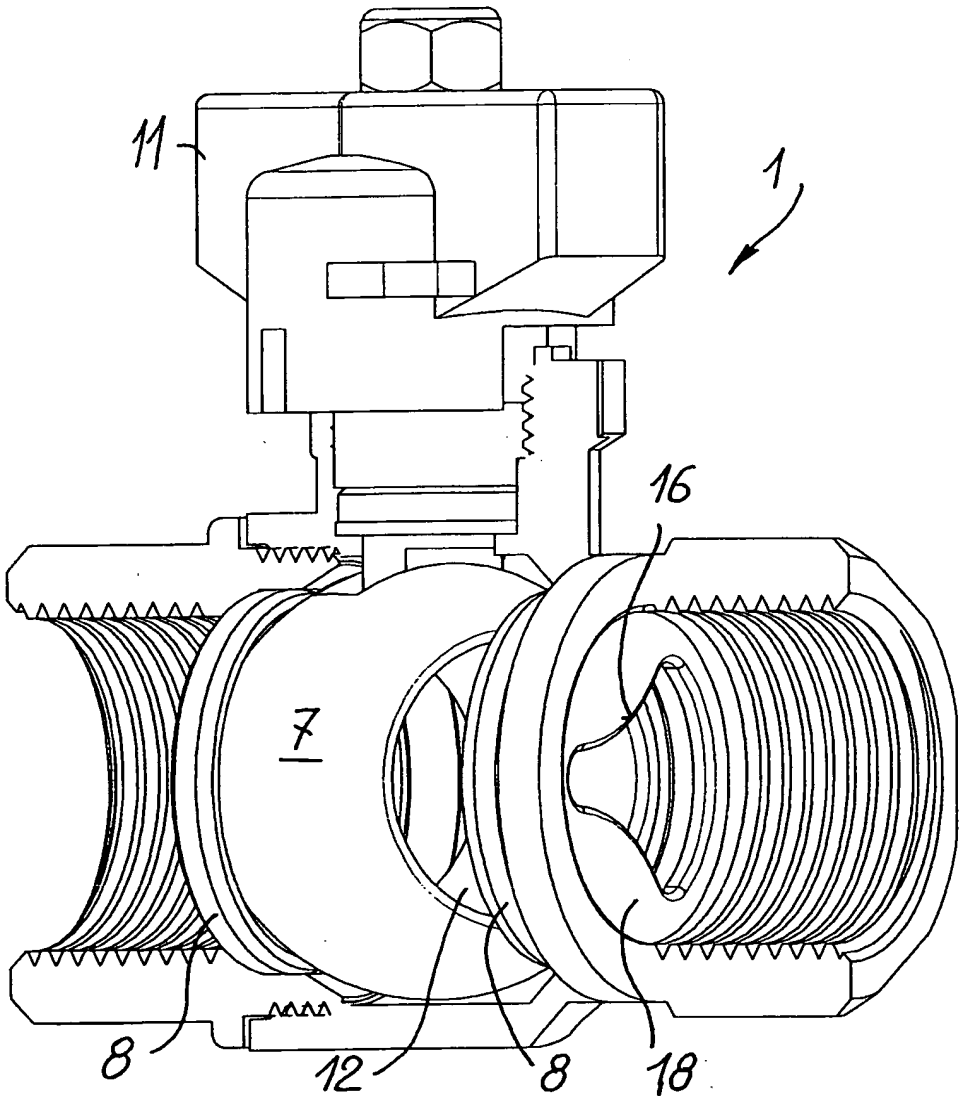

FIG. 7

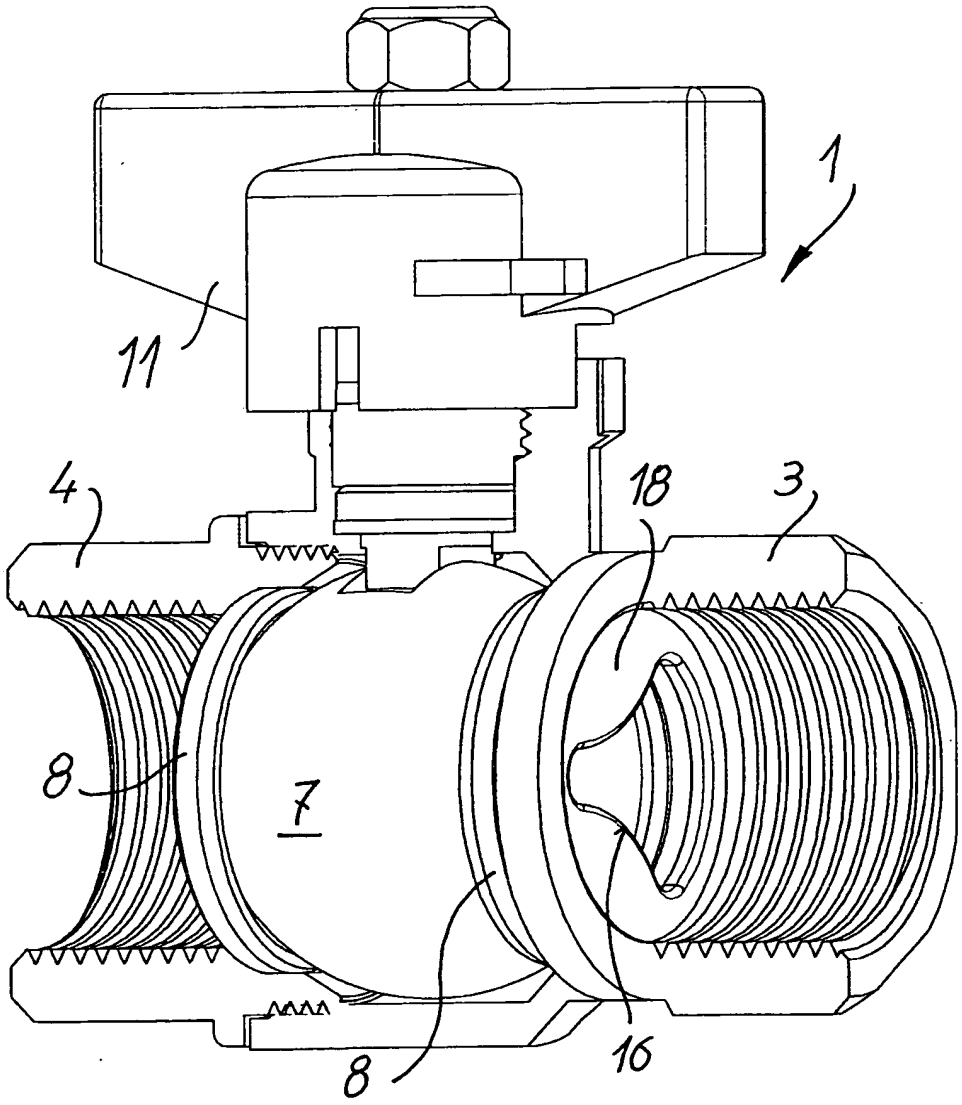

FIG. 8

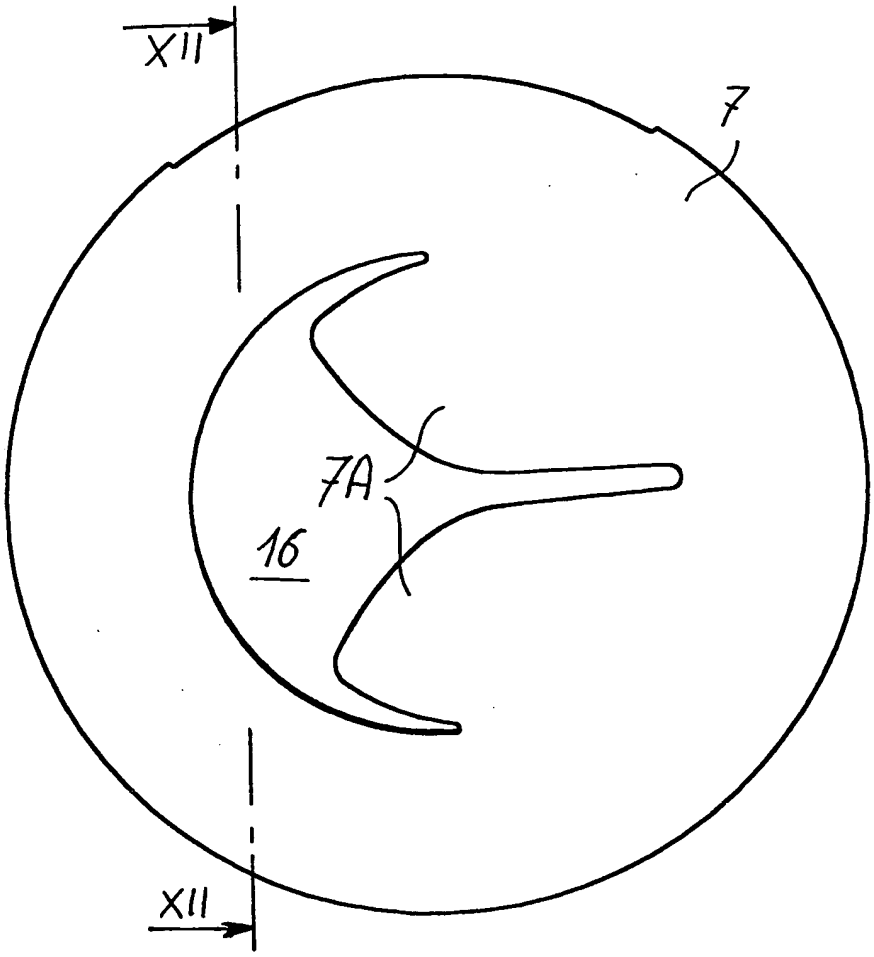

FIG. 9

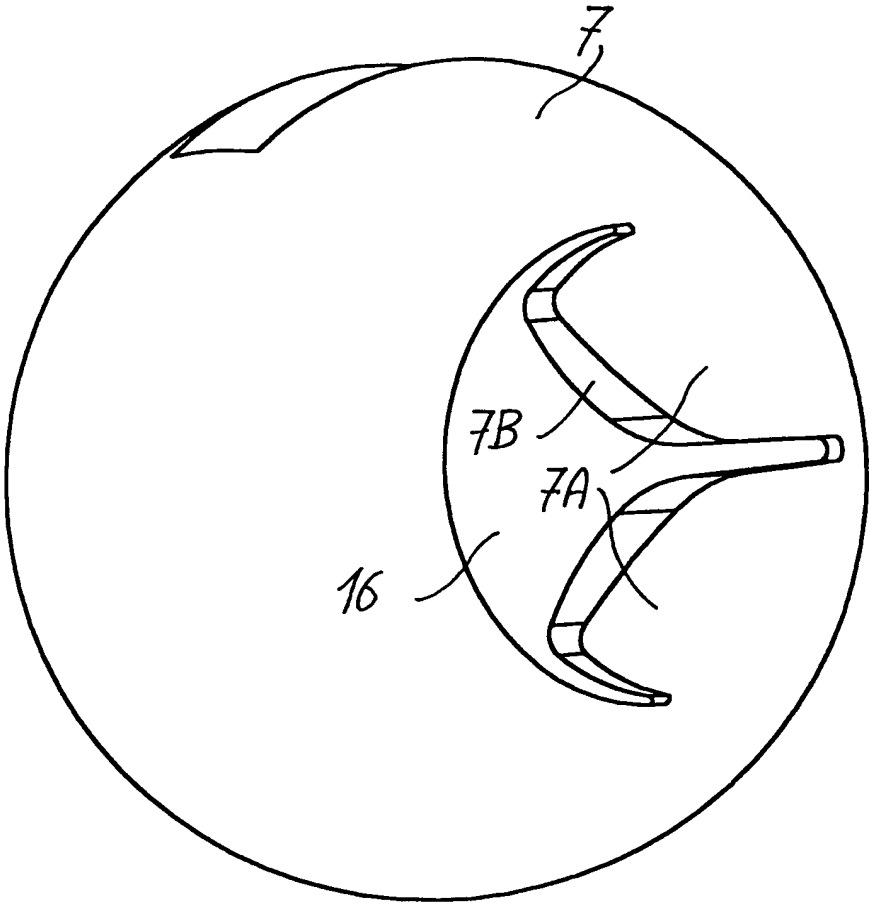

FIG. 10

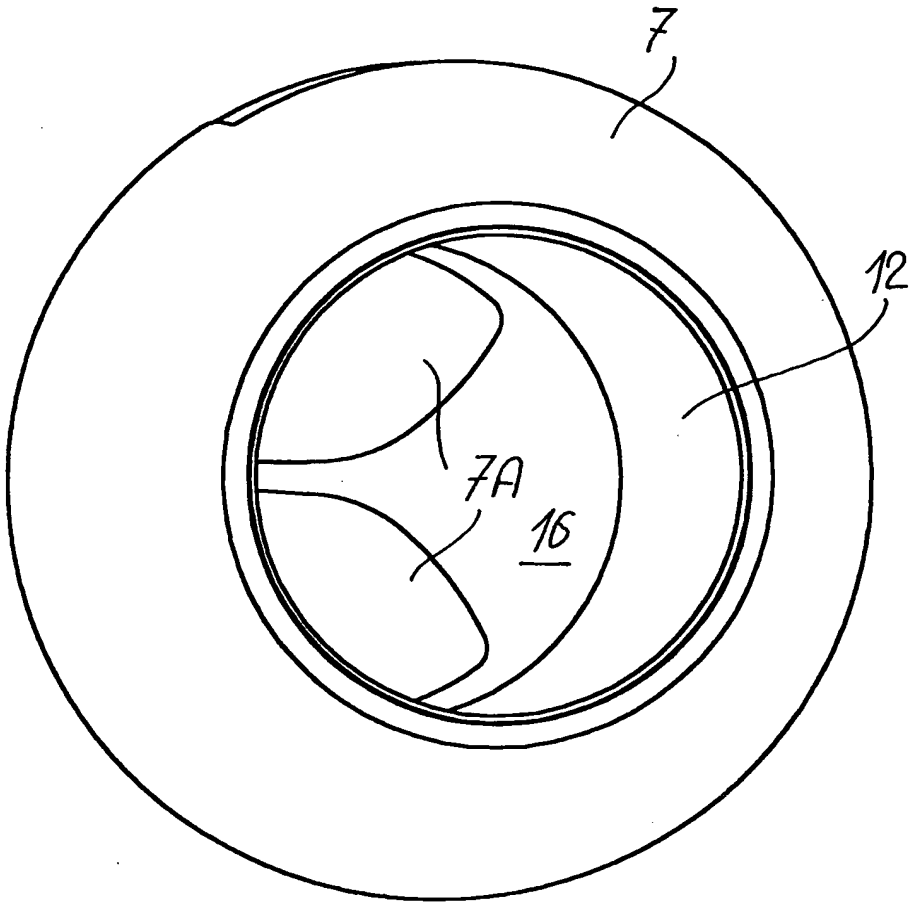

FIG. 11

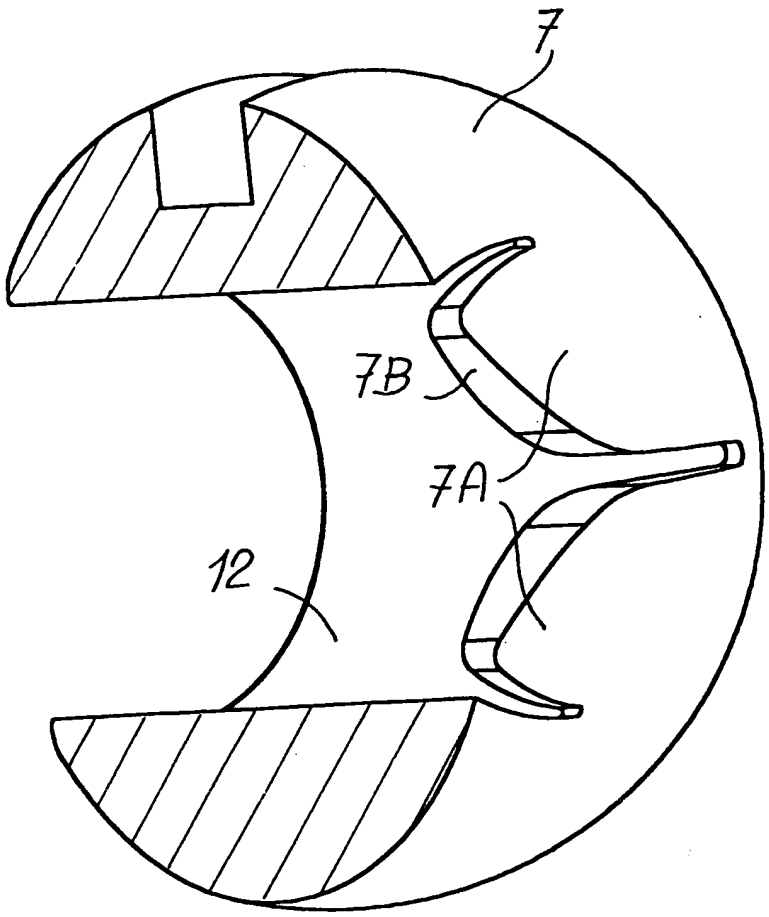

FIG. 12

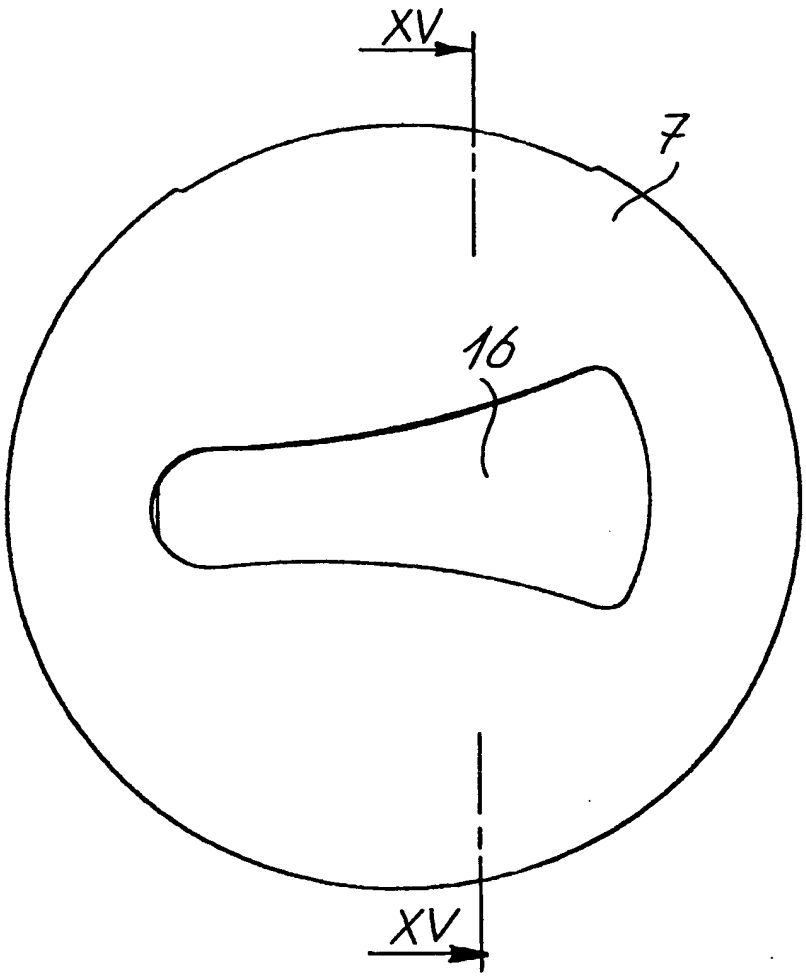

FIG. 13

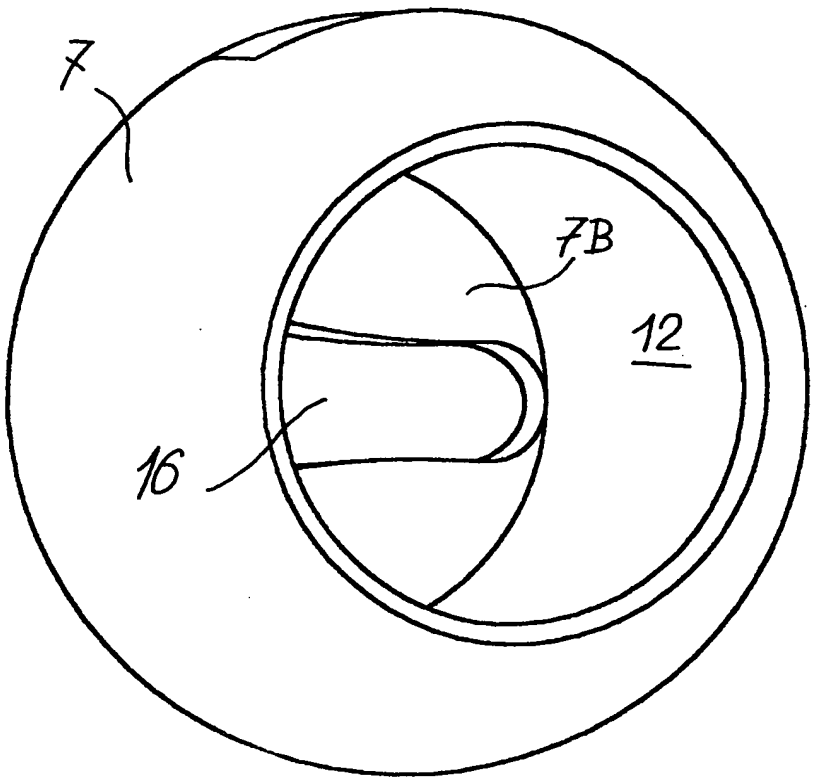

FIG. 14

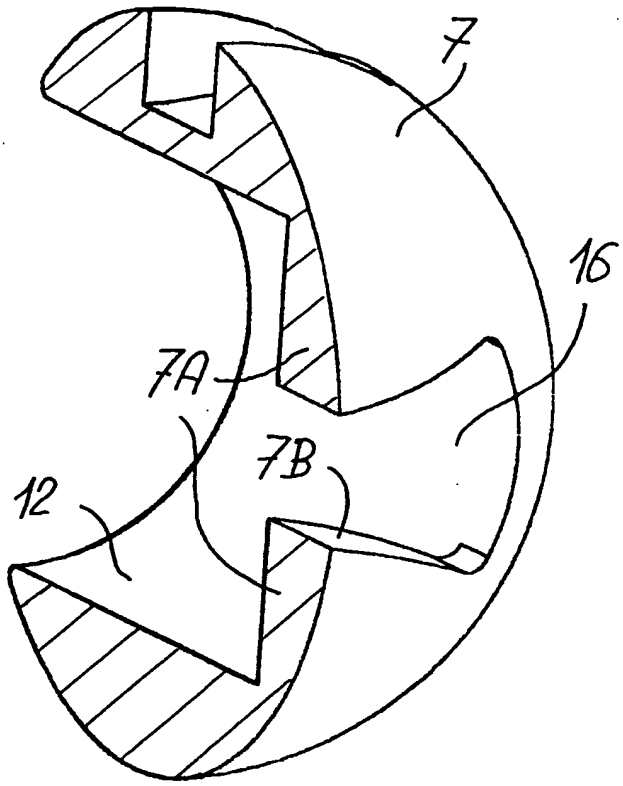

FIG. 15

INTERNATIONAL SEARCH REPORT

Int. ational Application No
PCT/EP 00/10754

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F16K5/12 F16K5/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F16K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 551 467 A (BOOTH WALTER ET AL) 3 September 1996 (1996-09-03) column 1, line 38 - line 41 column 3, line 42 - line 64 column 4, line 35 - line 57 column 5, line 8 - line 15 figures 2-6	1-3,5,6, 10,11
X	EP 0 309 678 A (BABCOCK WERKE AG) 5 April 1989 (1989-04-05) column 2, line 26 - line 42 column 2, line 55 -column 3, line 28 figures 1-5	1-3,5,6, 10,11

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
21 March 2001	28/03/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Ceuca, A-N

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INTERNATIONAL SEARCH REPORT

Int .tional Application No
PCT/EP 00/10754

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 1 151 661 A (HONEYWELL INC.) 14 May 1969 (1969-05-14) page 2, line 105 - line 106 page 2, line 129 -page 3, line 13 page 3, line 37 - line 50 figures 1,2 page 2	1-4,10, 11
A	EP 0 503 195 B (WORCESTER CONTROLS CORP) 16 September 1992 (1992-09-16) cited in the application column 6, line 15 - line 53 column 7, line 7 - line 21 column 8, line 10 - line 24 figures 1-6	1,2,4,6, 7,9-11
A	"METAL CHARACTERISED SEATS INCREASE RANGEABILITY FOR PRECISION THROTTLING CONTROL VALVES" DESIGN ENGINEERING,GB,MORGAN-GRAMPIAN LTD. LONDON, 1 June 1989 (1989-06-01), page 27 XP000032833 ISSN: 0308-8448 page 27, column 1, paragraph 4 -column 2, paragraph 1 figures 1-3	1,2,4,5, 10,11
A	DE 41 15 101 A (TOTAL FEUERSCHUTZ GMBH) 12 November 1992 (1992-11-12) column 1, line 67 -column 2, line 37 figures 1-11	1,2,4, 10-12

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INTERNATIONAL SEARCH REPORT

Information on patent family members

Im ational Application No
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